August 24, 2006

To: Prattsburgh Town Board
Steuben County Industrial Agency

Subject: Wind Turbine Noise Analysis Errors and Requirements, Comments on UPC Wind (Windfarm Prattsburgh) wind farm proposal

This is a supplement to the comments I made to the SCIDA at the Prattsburgh public comment meeting July 20, 2006.

Wind turbine noise added to the prevailing ambient background sound is an important environmental consideration when siting wind turbines since they are a permanent installation and their noise may significantly impair the enjoyment of neighboring lands. Relevant consideration of noise impacts are a specific requirement of a State Environmental Quality Review procedure.

The Windfarm Prattsburgh noise study for this DEIS was submitted by Hessler Associates dated May 31, 2005. Their study consists of two parts, identification of the ambient background noise and then analysis of the turbine noise influence. For the background ambient, Hessler exclusively relies on the associated Ecogen windfarm study conducted by the Hayes McKenzie Partnership. From the DEIS:

> This assessment essentially consists of two major parts. The first is an evaluation of the background sound levels that currently exist in the project area based on an extensive field survey carried out by the Hayes McKenzie Partnership (HMP) for Ecogen, LLC in December of 2004 and January of 2005. Ecogen is currently planning a wind turbine project similar in scale to WindFarm Prattsburgh in the same area and, in fact, **the turbines from each project are essentially intermingled over the entire site**. Because the HMP study, which is currently in the public domain as a part of Ecogen's draft generic environmental impact statement (DGEIS) filing with the State of New York, is exhaustive and covers the WindFarm Prattsburgh project area, **an additional survey was not necessary.**

The NYSDEC has a Program Policy "Assessing and Mitigating Noise Impacts" (Department ID DEP-00-1), which is the guidance UPC Wind used, that provides a detailed description of sound measurement methods, acoustical environmental factors and levels that are considered intrusive when making siting decisions.

The Hessler study is flawed and does not conform to the Policy it is adhering to:

a) All potential receptors that may be affected by unreasonable noise levels must be characterized, not just surrounding the 6 background measurement sites as was done by Hayes McKenzie because unique acoustical features of the terrain may influence sound propagation.
b) Measurements of background noise were completely inaccurate and do not provide a baseline for establishing noise contour maps. It is not conforming to

SEQR to rely on an adjoining project's environmental review, especially since that study is, as will be shown, so severely flawed as to be utterly useless.

c) Vegetation was not present for the short duration field measurements, and vegetative cover will have an important effect on elevated noise source propagation. Wind strength increases with elevation above earth and its frequently expected that the turbines will be operating just above cut-in while the land nearby is without wind or with very low wind.

From the Policy:

> B. Potential for Adverse Impacts
> Numerous environmental factors determine the level or perceptibility of sound at a given point of reception. These factors include: **distance from the source of sound to receptor; surrounding terrain; ambient sound level; time of day; wind direction; temperature gradient; and relative humidity**. The characteristics of a sound are also important determining factors for considering it as noise. The **amplitude (loudness), frequency (pitch), impulse patterns and duration of sound all affect the potential for a sound to be a noise.** The combination of sound characteristics, environmental factors and the physical and mental sensitivity of a receptor to a sound determine whether or not a sound will be perceived as a noise. This guidance uses these factors in assessing the presence of noise and the significance of its impacts. It relies upon qualitative and quantitative sound evaluation techniques and sound pressure level impact modeling presented in accepted references on the subject.

(emphasis added)

The successful measurement and assessment of the complex noise potential of a large wind turbine farm project is therefore vitally important and there are specific instructions in the Policy about excessive noise:

> When a sound level evaluation indicates that receptors **may experience sound levels or characteristics that produce significant noise impacts or impairment of property use**, the Department is to require the permittee or applicant to **employ reasonable and necessary measures to either eliminate or mitigate adverse noise effects**.

The background ambient determination is important because the new wind turbine noise emissions will be added with the ambient to provide a "limit of acceptance." The DEC Noise Policy suggests a 3 dB(A) increase over ambient for "sensitive receptors" and a generally applicable limit of 6 dB(A) increase as acceptable under most circumstances. Therefore the computer modeling of noise contours around each turbine depends exclusively on obtaining reliable ambient background noise data. Inaccurate noise contours and inaccurate background noise limits will lead to serious errors in delineating setback requirements for turbine siting. The Hayes McKenzie study itself underscores the importance of field noise measurements:

> "…. however, if ambient noise levels are found to be lower than the assumed values, then set back criteria will be greater than 1000' for the same wind turbine source noise levels. **To determine any increased set back distance criteria requires knowledge of the ambient noise environment into which the wind turbine noise is to be introduced**." (Ecogen LLC Prattsburgh/Italy Wind Farm: Noise Impact Assessment Report 1508-R-1, Other Guidance 4.3)

Close analysis of the Hayes McKenszie study reveals however that the background noise levels were **not** measured due to overwhelming contamination of measurements by the wind blowing through the noise meter microphone. To take background ambient sound measurements Hayes McKenzie put an acoustical microphone on a tripod support at the measurement site. The microphone has a spherical wind screen attached and is connected to recording electronics. Fig 1 is a photo excerpt from a typical setup that was used. This one is from Ecogen LLC Prattsburgh/Italy Wind Farm Noise Impact Assessment Report 1508-R1, Appendix 2, RP 7, p 5.

Fig 1: Hayes McKenzie (Ecogen) Typical Background Sound Measurement Setup

It is well known that wind induced microphone noise is a large source of error in any windy measurement situation. The reader may recall news broadcasts where the reporter is trying to talk despite breezes causing “wind noise” that overcomes the reporter’s voice. It’s the same thing here, a breeze on the microphone, even with a wind screen, will cause significant errors due to this unwanted effect. Noise meter manufacturer data clearly show the error and it has been studied theoretically, with good agreement between theory and instrumentation (see *The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise* by Godefridus Petrus van den Berg,Chapter 8 “Rumbling Wind: wind induced sound in a screened microphone”) Larson-Davis makes the noise meter used by Hayes McKenszie. At my request they supplied to me a graph of noise error due to wind, Fig 2.

Other manufacturers have similar errors. Fig. 3 shows a plot of wind speed vs. dB(A) error for the Larson-Davis and a Rion noise meter (used in UPC Wind’s Cohocton Noise analysis), and two conditions for the van den Berg model. All are in good agreement. Also shown on the graph as vertical bars are the cut-in wind speed and cut-out wind speed for the GE 1.5 MW turbine (3.5 m/s and 25 m/s, from GE spec). It can be seen that at the cut-in wind speed the noise meter error is about 35 dBA. Unless the background noise being measured is above 35 dBA it won't be registered. Since wind itself is completely silent, it creates sound only when acting on some object causing it to react to the wind pressure. The wind may not create an "ambient" of 35 dBA, depending on physical conditions around the measuring site – nearby woods and vegetation, structures, and terrain. At the turbine cut-out wind speed of 56 mph the microphone error has risen to an astonishing 80 dBA. Only loud background sounds can be now be registered, with no way of discerning any quieter ambient.

A study on behalf of the United Kingdom's Energy Technology Support Unit called "Noise Immission from Wind Turbines" (Feb 10, 1999) evaluated some methods of correcting erroneous noise meter measurements:

> "The project has dealt with practical ways to reduce the influence of background noise caused by wind acting on the measuring microphone."

The report identifies four methods to eliminate microphone error, none used by Hayes McKenzie:

> "3.1.1 Reduction of Wind Induced Microphone Noise
>
> Wind induced microphone noise is a major problem in wind turbine noise measurement during strong wind. Four techniques for reducing this so-called pseudo noise were tested in the project.
>
> - *Two microphone cross correlation*. Noise signals from two identical microphones positioned some distance apart were analyzed applying correlation technique to suppress wind induced noise components, which are uncorrelated in the two signals[4]
> - *Mounting the microphone on a vertical reflecting board.* The board reduces wind velocity at the microphone, screens the noise from any source behind the board, and causes pressure doubling (+6 dB) for sources in front of the board.
> - *Directional microphone with supplementary wind shield*. A directional microphone reduces noise from directions other than that of its axis. Wind noise sensitivity of the directional microphone was reduced by mounting a supplementary wind shield.
> - *Large secondary wind screen.* An extra wind screen used simultaneously with the normal wind screen reduces wind noise. The attenuation of the acoustic signal when transmitted through the secondary wind screen was measured in an anechoic room and the wind induced noise was measured in the field.
>
> The reduction of wind-induced noise turned out to be more or less the same no matter which of the methods is used…"

United Kingdom Criteria

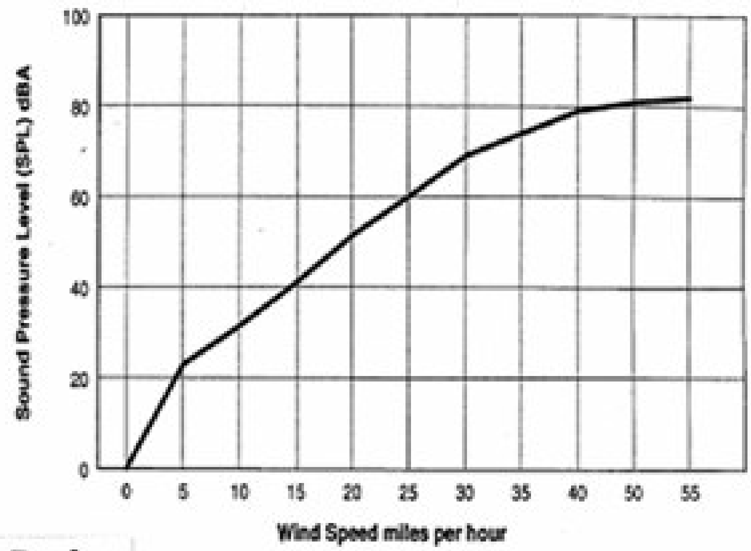
Several other reports identify rural, country ambient sounds as about 30 dBA, or frequently quieter, and that quieter noise levels in the 30 dBA range should be used as opposed to urban environments that frequently allow 50 dBA limits. For example, Wind turbines in Europe are more widely established and noise studies there indicate that in

8.7 Wind Noise

The microphone is mounted such that winds up to 20 m.p.h. do not cause vibration levels at the microphone resulting in microphone outputs above 60 dBA.

Using the capability of the Larson•Davis RMS to interface directly to windspeed sensors, a complete Model 2100K microphone system with rainhat, windscreen, and bird spikes was tested in actual variable wind conditions out-of-doors. Data were logged simultaneously for windspeed and A-weighted sound pressure level; resulting data are plotted in Figure 16.

FIGURE 16. Wind Screen Noise for the Model 2100K Outdoor Microphone Syste



Larson Davis
A PCB GROUP CO.
David Ahlstrom
Repair & Calibration Manager
1681 West 820 North
Provo, Utah 84601
PH. 801 375-0177
Direct 801 354-0202
FAX 801 354-0203
david_ahlstrom@larsondavis.com
www.larsondavis.com

In the above figure, A-weighed sound pressure levels are correlated over a 0-55 mile per hour (0-88 km/hr) range. The 50 dBA limit is reached at 20 miles per hour or 8.9 m/s.

The microphone assembly, tilt-down tower have been designed to withstand wind velocities of 100 m.p.h. without permanent damage.

Fig 2: Measurement Error Due to Wind Speed over Microphone – Larson-Davis

terrain similar to Cohocton and other WNY areas low noise backgrounds are to be expected, that the wind turbines noises are therefore much more objectionable, and that setbacks up to 1 mile, or more, are needed.

From : *Location, Location, Location, An investigation into wind farms and noise by the Noise Association,* by John Stewart, UK Noise Association

Wind Farm Noise – the impact on areas of low background noise

Mid Wales -a land of hills and valleys. A place where the wind blows frequently and the population tends to be thinly spread. Ideal for wind farms. And, not surprisingly, many are planned. **The best place very often for the turbines to catch the wind is close to the top of a hill**. It means that the wind turbines can be at their most productive. But it also means that the **noise may cascade down the surrounding valleys**. To makes matters worse, many of the scattered hamlets within the valleys snuggle into corners protected by the hills and the mountains where the background noise level is very low indeed. **You only need to visit these areas to hear the 'swish, swish, swish' of the turbines – particularly downwind – over a mile away from the wind farm.**

(emphasis added)

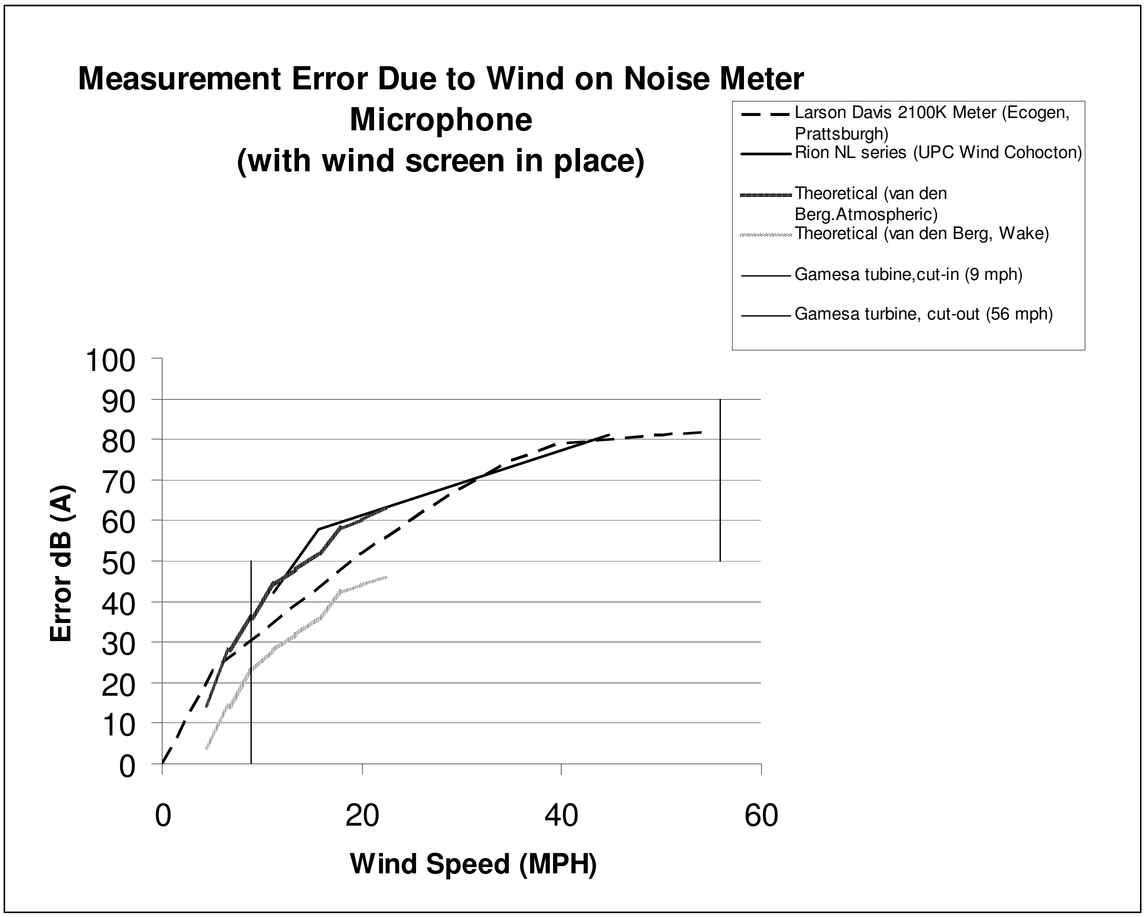


Fig 3: Noise Meter Microphone Error (Bolton)

The description of Mid Wales above describes Cohocton and much of scenic Western New York. The prevailing (urban) UK national guidelines for noise limits are (from Stewart)

- Daytime noise levels outside the properties nearest the turbines should not exceed 35-40dB(A) or 5dB(A) above the prevailing background, whichever is the greater.
- Night noise limits outside the nearest property should not exceed 43dB(A) or 5dB(A) above the prevailing background, whichever is the greater.

But in areas like Mid Wales, the guidelines are deemed by the UK Noise Association to give noise levels too high. Likewise with Prattsburgh, a lower noise threshold in the 35 dBA range is to be anticipated. The DEC Noise Policy gives acceptable noise levels about 6 dBA higher than the prevailing background. The background must be accurately measured however.

Further corroboration comes from Dick Bowdler, "a noise and acoustic consultant for more than 30 years and most of my current work is dealing with the assessment of environmental noise as it affects residential properties. I work equally for those potentially creating noise and those affected by it. I have been a supporter of wind energy and other forms of renewable energy for some 35 years. " (private letter to Susan Sliwinski, Oct. 16, 2002). Continuing, he says:

> In practice, in most rural areas, my rule of thumb is that the nearest turbine needs to be at least 1¼ miles from any house. However, these are areas where the background noise level can be 20dBA at night. You suggest that your background noise level could be 30-32dB. This seems a likely figure if you have 350 houses in the area, though I suspect it could be a bit lower than this. On this basis, noise from the wind farm should not exceed 35dBA. **If the developers are suggesting that 55 decibels is acceptable, this is quite outrageous. 55dBA is more than four times as loud as your background noise.**
>
> Most of the Scottish wind farms that have recently been approved have no housing closer than about 1 mile, except where the house belongs to the landowner of the wind farm site. There are a few applications with houses as close as about 2000 feet but these have all either been turned down or withdrawn by the developer.
>
> I am not familiar with the GE turbines, but I suspect that they have a sound power level of about 105dBA. In this case, the noise level would be between 45 and 50dBA at 1400 feet in neutral weather conditions and if the nearest turbines were in full view. (emphasis added)

NASA

Noises carry greater distances from elevated noise sources like wind turbines and this has been reported by NASA in a 1990 study *Wind Turbine Acoustics* by Hubbard and Shepherd. From the Introduction:

> Wind turbine generators… are producing electricity both singly and in wind power stations that encompass hundreds of machines. Many installations are in uninhabited areas far from established residences, and therefore there are no apparent environmental impacts in terms of noise. There is, however, **the potential for situations in which the radiated noise can be heard by residents of adjacent neighborhoods, particularly those neighborhoods with low ambient noise levels**. …
> (emphasis added)

This report contains detailed noise analyses of various wind turbine styles – upwind rotors vs. downwind rotors, blade shape, rotational speed etc. And it includes a detailed sound propagation analysis. Sound "bends" (refracts) in the atmosphere much like light refracts in striking a lens. A graph of the effect, from the report, is shown in Fig 3 below.

The "Shadow" zone in Fig. 4 may explain the observed "quietness" experienced by observers when taken to stand near wind farm turbines such as Fenner. The noises are masked unless the observer is 4x the tower height distance. And it underscores the necessity of comprehensive and accurate engineering studies of complex phenomena. Merely relying on anecdotal "I don't hear anything" knee jerk responses to a turbine visit is misleading and hardly equivalent to living year round as a "receptor".

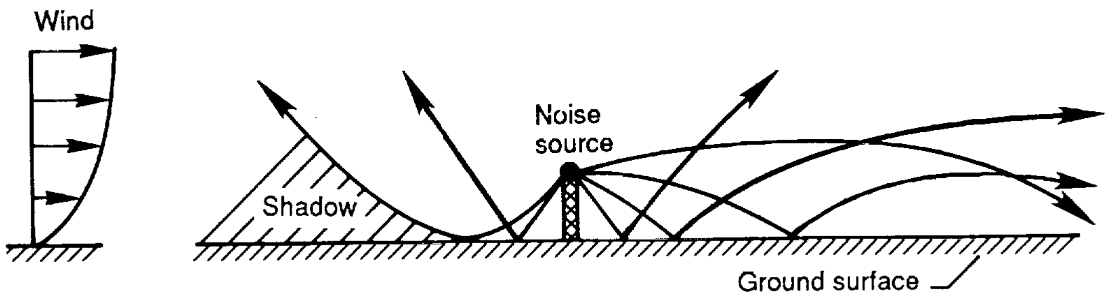


Figure 7-20. Effects of wind-induced refraction on acoustic rays radiating from an elevated point source [Shepherd and Hubbard 1985]

Fig 4: Sound Refraction Effects

Recall from the Mid Wales description above that turbine sounds carry one mile. This is as well by the NASA study, Fig 5 below, for a single "point source" turbine. The sounds carry further for a "line" of turbines and many wind farms do have linear clusters of turbines along a hill ridge that add about 6 dB

From the Figure it can be seen that the sound drops about 30 dB (for 1,000 Hz, the most sensitive to human hearing) at 1,000 meter (about 3,000 ft). The Gamesia G87 wind turbines have about a 100 dBA noise level at the turbine (Hessler's Noise Impact Assessment Windfarm Prattsburgh Project, Table 3.2.1.2) and therefore at 3,000 ft the noise is 100-30 = 70 dB. At one mile (5280 ft = 1609 meter) the chart, which has a logarithmic scale, gives about a 60 dB drop, or 40 dB remaining (100-60= 40). The 40 dB figure is about what the Europeans use for their noise boundary, with the 1 mile setback. Notice that for low-frequency sounds, such as the blade-support tower induced "whosh" (250 Hz on the graph), that the sound carries much further, out to 2 miles.

To confirm the reasonableness of the NASA report one can look again at the DEC Noise Policy (Table C, "Projected Noise Levels") and find for example a Hitachi earth moving shovel starting at 92 dBA then falling to 56.5 dBA at 3,000 ft, a decline of 35 dBA. Looking at Fig 5 we find a 35 dB drop at 1,000 m (3,000 ft), in good agreement.

Indeed, even the Hessler study contains a table for construction equipment noises, reproduced in Fig 6 below, in direct conflict with their own turbine noise analysis.

Note that the construction equipment emits 88 dBA, falling to 44 dBA at 4,200 ft (4/5 of a mile). This is a 44 dBA drop for a ground-level emitter. Compare this to the Hessler contour map (Expected Sound Contours of WindFarm Prattsburgh Turbines... Plot 1), excerpted with a scale added as Fig. 7 below. Their map shows the highly elevated and radiating wind turbine falling from about 100 dBA emission to 44 dBA at their proclaimed acceptable boundary in merely 1,300 ft. This is quite a preposterous conflict and strongly suggests a serious error with the modeling analysis by Hessler.

For comparison in Fig. 7 is the 1 mile distance that would, if formed into a contour around each turbine location, include an incredible portion of the entire Town itself!

Distance Effects

Point Sources

When there is a nondirectional point source as well as closely grouped, multiple point sources, spherical spreading may be assumed in the far radiation field. Circular wave fronts propagate in all directions from a point source, and the sound pressure levels decay at the rate of −6 dB per doubling of distance in the absence of atmospheric effects. The latter decay rate is illustrated by the straight line in Figure 7-18. The dashed curves in the figure represent increased decay rates associated with atmospheric absorption at frequencies significant for wind turbine noise.

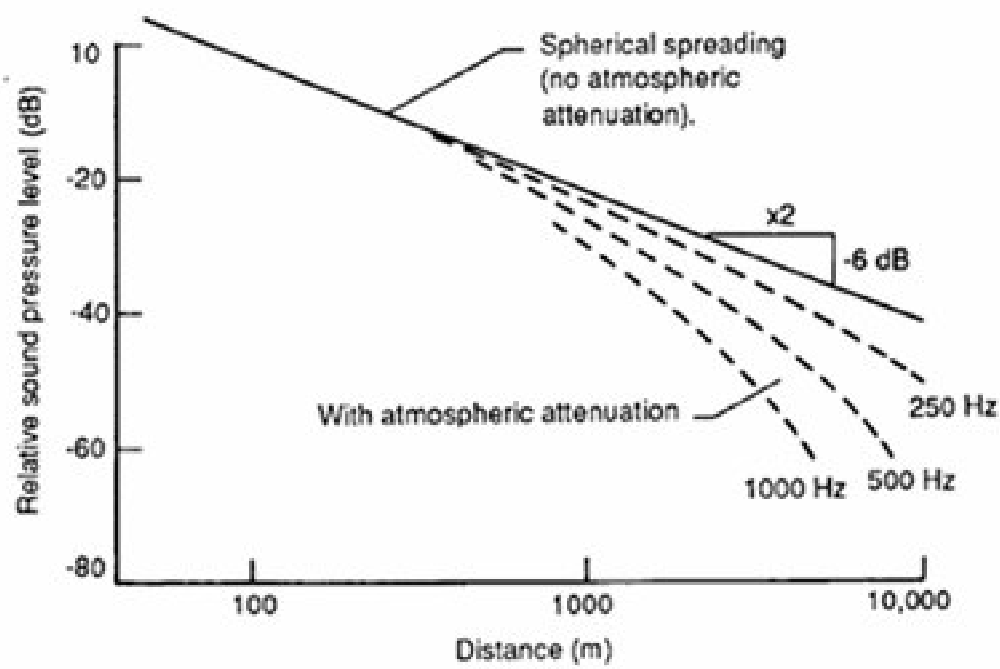


Figure 7-18. Decrease in sound pressure levels of pure tones as a function of distance from a point source [ANSI 1978]

Fig 5: From "Wind Turbine Acoustics" by H.H. Hubbard and K.P. Shepard, NASA Technical Paper 3057, 1990, Fig 7-18

Table 3.8.1 *Construction Equipment Sound Levels by Phase*

Equipment Description	Typ. Sound Level at 50 ft., dBA [7]	Est. Maximum Total Level at 50 ft. per Phase, dBA*	Max. Sound Level at a Distance of 1200 ft., dBA	Distance Until Sound Level Decreases to 44 dBA, ft.
Road Construction and Electrical Line Trenching				
Dozer, 250-700 hp	88	92	61	4200
Front End Loader, 300-750 hp	88			
Grader, 13-16 ft. blade	85			
Excavator	86			
Foundation Work, Concrete Pouring				
Piling Auger	88	88	57	3200
Concrete Pump, 150 cu yd/hr	84			
Material and Subassembly Delivery				
Off Hwy Hauler, 115 ton	90	90	59	3700
Flatbed Truck	87			
Erection				
Mobile Crane, 75 ton	85	85	54	2600

Fig 6: Construction Equipment Noise and Distance Table

To better understand the cause of the discrepancies I called Rick Peppin (8-24-06) with Scantek, U.S. distributor of the DataKusik Corp. "CadnaA" environmental modeling software used by Hessler. He believes the input data to the software must be carefully analyzed to see what Protocols and Table of Sources were used, to be sure no errors were made in establishing model criteria. Also, if the model is following ISO 9613.2 there may be some additional accuracy issues.

Vegetation

The noise study was conducted for a brief period in January/February, when vegetation is lacking. Hessler actually attempts to dismiss this as an advantage:

> Moreover, it is important to note that this survey was conducted during the winter when the trees were bare, acoustically absorptive snow was on the ground for a portion of the survey period and no appreciable insect or bird sounds were present. In the summertime, when outdoor activities are more common and windows might be open, higher background levels due to leaf rustle and insects can be expected to significantly increase the amount of background sound level masking. In addition, wind speeds in New York state are generally lower in the summer, meaning that the turbines will operate less frequently and at generally lower, quieter rotor speeds.

Fig 7: Excerpt of Expected Sound Contours of WindFarm Prattsburgh Turbines, with Distance Scales

It would however seem intuitively obvious from my own experience living in quiet rural setting that ambient noises in the summer are often much less than the winter, absorbing road noises and other distant sounds. And since the wind turbines are elevated and directly radiating, their noise will be more easily heard against a much lower background due to summer vegetation. Winds increase with elevation and in the summer the wind may be silent at the ground while the wind turbine is active.

And, from the DEC Noise Policy, in direct conflict with Hessler:

> A. Environmental Setting and Effects on Noise Levels
>
> 4. Time of Year - **Summer time noises have the greatest potential for causing annoyance** because of open windows, outside activities, etc. During the winter people tend to spend more time indoors and have the windows closed. (emphasis added)

Conclusion

This wind farm project is very large and has a potentially large noise footprint on the entire town. An accurate and comprehensive noise analysis is essential but clearly the Hessler/Hayes McKenzie study is critically flawed. This study must be repeated with far better analysis in terms of a) reasonably accurate background levels b) inclusion of summer vegetation c) measurement sites that comprehensively represent the likely intrusion on non-leaseholder lands and dwellings. These requirements must be satisfied to conform to the NYS SEQR law:

> In circumstances where noise effects cannot readily be reduced to a level of no significance by project design or operational features in the application, the applicant **must evaluate alternatives and mitigation measures in an environmental impact statement to avoid or reduce impacts to the maximum extent practicable** per the requirements of the State Environmental Quality Review Act.

Many sites may be found to be unsuitable for use due to unacceptably high noise levels requiring higher setbacks, with 1 mile an expected outcome from a genuine study. Mitigation suggestions from the DEC Noise Policy include "increasing the setback distance". It is entirely likely that other turbine locations must be sought, or the scale of the wind farm must be reduced.

Once more from the DEC Policy "Background"

> When lands adjoining an existing or proposed facility contain residential, commercial, institutional or recreational uses that are proximal to the facility**, noise is likely to be a matter of concern to residents or users of adjacent lands.**

Richard Bolton
President of Environmental Compliance Alliance, non profit corporation dedicated to supporting legitimate agency environmental review and public information.
Physics Dept. Tech, Hobart and Wm Smith College
Project Design Engineer, Eastman Kodak (ret), 30 years, 5 U.S. Patents.
President of Bare Hill Software Co, manufacturer of engineering software.
BS Physics, University of Rochester w/ graduate physics courses.